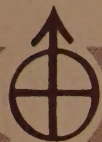


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Vegetal Mass of the Tundras of Western Taimyr

E.B. Pavlova



TUNDRA BIOME - INTERNATIONAL BIOLOGICAL PROGRAM

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VEGETAL MASS OF THE TUNDRAS OF WESTERN TAIMYR

There have been few published reports dealing with the productivity of tundra phytocoenoses. The report by V.D. Aleksandrova (1958) is the first to give data on the aboveground and root vegetal mass of the arctic tundra; an estimate of the mass of all components of the plant community is given. Similar data have been published for the shrub tundras of the Koryak land (Vikhireva-Vasil'kova et al., 1964).

The data published in this paper were collected in the summer of 1967 in the Taimyr National Okrug, Krasnoyarsk Krai. We used the methodology of V.D. Aleksandrova (1958). In the more typical plant communities of the region plots measuring 50×50 cm were laid out (repetition fourfold). From each plot all of the aboveground parts of the plant were cut off, divided into groups of species and weighed separately by groups. The dead twigs and leaves were weighed separately. To determine the underground mass specimens were taken (fourfold) from plots measuring 15×15 cm. Soil monoliths were separated with respect to genetic horizons down to the permafrost table and washed in gauze bags and in a net (0.25 mm) in running water.

The first region in which we carried out the investigations was located in the subzone of shrub and cottongrass-tussock tundras 70 km upstream from the mouth of the Agapa River, which flows into the Pyasina River. An investigation was made of the phytomass of the following types of tundra.

1. Spotty shrub-sedge-moss tundra. This type is located on well-drained sections of interfluves, hills and terraces. The spots are bare, wrinkled and invaded by vegetation. They have a diameter of 50 to 200 cm and occupy from 10 to 30% of the surface. Along slopes they are usually oval, extending along the slope. Between the spots is a thick peat-moss layer (15-20 cm) with large and small shrubs. Lichens are very rare and do not occur between the spots. The borders surrounding the bare spots, rising 7-10 cm, are covered by a thin moss carpet including lichens (*Cetraria cucullata*, *Cladonia silvatica*). Shrubs and sedges grow on this carpet. Spots that are being invaded by vegetation have a unique complex of plants that is constant for many tundras of this region. It includes the following: *Vaccinium vitis-idaea*, *Dryas punctata*, *Tofieldia nutans*, *Equisetum arvense*, *Juncus castaneus*, *Luzula arctica*, *Carex capillaris**. The soil is clay loam, gleyey at the surface and on the spots, and peat-gleyey between the spots where by the middle of July the depth of thawing is 30-50 cm, whereas under the spots it is 80 cm. From 11 to 22 July the mean temperature of the soil at a depth of 20 cm was 5.8°C between the spots and 8.2°C at the spots. At a depth of 5 cm the corresponding temperatures were 7.6°C and 11.3°C . On hot days the surface of the moss reaches a temperature of $20-30^{\circ}\text{C}$ and at night it cools to 10°C .

In order to investigate the phytomass and its composition, specimens were taken from the left bank of the Agapa River (Table I). The spots here are being invaded by vegetation or are grown over. The composition of the living aboveground vegetal mass is as follows: Shrubs - *Betula exilis*, *Salix pluchra*, *S. glauca*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Cassiope tetragona*, *Ledum decumbens*, *Dryas punctata*; grasses and sedges - *Arctagrostis latifolia*, *Eriophorum vaginatum*, *Carex hyperborea*; forbs - *Lagotis stelleri*, *Saxifraga hieracifolia*, *Minuartia arctica*, *Tofieldia nutans*, *Parrya nudicaulis*, *Valeriana capitata*, *Saxifraga punctata*, *Polygonum ellipticum*, *Pedicularis capitata*, *P. lapponica*, *P. sudetica*; mosses - *Aulacomnium turgidum*, *Tomenthypnum nitens*, *Hylocomium splendens*.

2. Cottongrass-shrub-moss tundra. This type is located on the interfluves in depressions between hills, on gentle slopes and in depressions on river terraces. The tundra is moist and tussocky with the tussocks being 30 cm in diameter and 15 cm high. The interstitial area is covered

* The names of flowering plants are those of Krylov (1927-1949), and those of mosses and lichens are taken from Dombrovska and Shlyakov (1967).

Table I. Vegetal mass of some types of plants in the shrub and cotton grass-tussock tundra subzone.

Organic matter	Type of tundra						Willow forb meadows on ridges near the river channel						Central floodplain					
	Interfluvial			Terrace			Terrace slopes			Sedge moss tundra			Sedge moss tundra			Sedge moss tundra		
	Spotty shrub-sedge-moss	Cottongrass-shrub-moss-tussock	Cassiopeium moss	Shrub-forb-meadow	Centners/ha	%	Centners/ha	%	Centners/ha	%	Centners/ha	%	Centners/ha	%	Centners/ha	%	Centners/ha	%
Total	858.8	100	1338.1	100	973.4	100	525.85	100	534.38	100	1275.2	100	1275.2	100	1275.2	100	1275.2	100
Underground mass	711.0	82.7	1249.0	93.3	848.8	87.2	485.6	92.3	506.6	94.8	1201.5	94.2	1201.5	94.2	1201.5	94.2	1201.5	94.2
Aboveground mass	147.8	17.3	89.1	6.7	124.6	12.8	40.25	7.7	27.78	5.2	73.7	5.8	73.7	5.8	73.7	5.8	73.7	5.8
Dead above-ground remains	79.2	9.2	24.7	1.9	66.15	6.8	14.25	3.1	9.08	1.7	39.2	3.0	39.2	3.0	39.2	3.0	39.2	3.0
Live aboveground mass																		
Total	68.6	7.9	64.36	4.8	58.45	6.0	26.0	4.6	18.7	3.5	34.5	2.8	34.5	2.8	34.5	2.8	34.5	2.8
Shrubs	16.2	1.88	15.62	1.1	20.4	2.47	13.2	2.5	13.05	2.5	1.25	0.09	1.25	0.09	1.25	0.09	1.25	0.09
Sedges and grasses	6.2	0.72	8.2	0.64	1.9	0.19	1.9	0.19	0.56	0.1	1.71	0.09	1.71	0.09	1.71	0.09	1.71	0.09
Forbs	1.1	0.02	0.28	0.02	0.95	0.04	0.44	0.08	5.04	0.9	traces		traces		traces		traces	
Mosses	45.1	5.2	40.3	3.01	35.2	3.6	9.51	1.8			31.5	2.7	31.5	2.7	31.5	2.7	31.5	2.7

by a dense moss carpet. The high predominance of underground mass over aboveground mass (Table I) is explained by the slow mineralization of dead roots and aboveground defoliation due to the high peatiness of the soil (the soil is peaty - gleyey with the permafrost table in the middle of June being at a depth of 35 cm).

The composition of the live aboveground mass is as follows: shrubs - *Betula exilis*, *Salix pulchra*, *S. lanata*, *S. hastata*, *S. glauca*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Ledum decumbens*, *Dryas punctata*; grasses and sedges - *Arctagrostis latifolia*, *Eriophorum vaginatum*, *Carex hyperborea*; forbs - *Valeriana capitata*, *Pedicularis lapponica*; mosses - *Aulacomnium turgidum*, *A. palustre*, *Tomenthypnum nitens*, *Polytrichum piliferum*, *Rhacomitrium canescens*, *Ptilidium ciliare*.

3. Cassiopeium-moss tundra is characteristic of well-drained sections of sandy terraces. As a rule it has many flowering forbs. The soils are slightly gleyey and thaw to a depth of 60 - 70 cm by the middle of July. From 11 to 22 July the mean soil temperature at a depth of 5 cm was 13.1°C and at a depth of 20 cm, 6.5°C. The daily amplitude in temperature at the soil surface was 18.4°C and on hot days the surface of the moss cover reached 38°C (at places protected from the wind).

The composition of the live aboveground mass was as follows: shrubs - *Salix lanata*, *S. pulchra*, *Betula exilis*, *Cassiope tetragona*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Dryas punctata*, *Salix herbacea*; grasses and sedges - *Carex hyperborea*, *Alopecurus alpinus*; forbs - *Armeria arctica*, *Polygonum ellipticum*, *P. laxmanii*, *Equisetum arvense*, *Astragalus danicus*, *Pirola grandiflora*, *Minuartia arctica*, *Arenaria graminifolia*, *Saxifraga bronchialis*, *Dianthus repens*, *Campanula rotundifolia*; mosses - *Hylocomium splendens* var. *alaskanum*, *Dicranum elongatum*, *Aulacomnium turgidum*, *Tomenthypnum nitens*.

4. Shrub-forb dry tundra of the middle type is characteristic of terrace slopes. The moss cover is slightly developed (individual beds of *Polytrichum piliferum*, *Aulacomnium turgidum*, *Tomenthypnum nitens*). The layer of high shrubs consists of *Betula exilis* and *Salix lanata* with an admixture of *Vaccinium uliginosum* and *Ledum decumbens*. In the second story there is *Carex stans* and the forbs *Pyrethrum bipinnatum*, *Pachypleurum alpinum*, *Myosotis asiatica*.

5. Colorful willow-forb meadows predominate in the floodplain. The complete absence of mosses and normal moisture content facilitates abundant stands of forbs in these places.

The composition of the living aboveground mass is as follows: shrubs - *Salix arbuscula*, *S. glauca*, *S. lanata*; forbs - *Hedysarum arcticum*, *Astragalus frigidus*, *A. alpinus*, *A. danicus*, *Equisetum arvense*, *Pyrethrum bipinnatum*, *Armeria arctica*, *Polemonium boreale*, *Pedicularis sudetica*, *P. oederi*, *Polygonum laxmanii*, *Arnica angustifolia*, *Senecio resedaefolius*; and others (of the total of 5.04 centners per hectare, legumes make up 3.92 centners per hectare); grasses - *Alopecurus alpinus*, *Trisetum spicatum*, *Festuca rubra*.

6. Sedge-moss tundra, varying from damp to boggy to almost dry, predominates in the central floodplain. A section with an average amount of moisture content was selected for taking the specimens. The soil is of the floodplain type with gley and clay loam, and thaws to a depth of 35 cm by the middle of July. Soil temperature is low, the average from 11 to 22 July being 2.9°C at a depth of 20 cm and 4.9°C at a depth of 5 cm. The mean maximum temperature at the moss surface is 29.2°C.

The composition of the living aboveground mass is as follows: shrubs - *Salix pulchra*, *S. glauca*; sedge - *Carex stans*; forbs - *Saxifraga hirculus*, *S. punctata*, *Lagotis stelleri*; mosses - *Aulacomnium turgidum*, *Tomenthypnum nitens*.

The second region of investigation was located in the basin of the Kosa River (tributary of the Dudinka), several kilometers from the Tundra Station of the Noril'sk Railroad in the northern treed tundra near the boundary with the southern shrub tundra. Investigations were carried out in the following tundra types.

1. Hummocky peat bogs occur extensively on terraces and interfluvies. They form a complex of peat hummocks covered by shrubs and lichens and separated by boggy depressions. The mounds, 10 - 20 m in diameter, are 60 - 80 cm above the low-lying area and they frequently have fissured moist spots of bare peat. At times the surfaces of the mounds are covered by sparse tussocks. The depressions are usually occupied by sedge (*Carex limosa* and *C. rotundata*) bogs. The moss cover consists basically of *Drepanocladus* sp., *Sphagnum russovii*, *S. squarrosum*. At times, particularly on large interfluvial hills, the depressions between peat mounds are deep fissures, apparently indicating the initial stages of peat bog degradation. The bottom of such a fissure has a continuous cover of *Ranunculus gmelinii* and the walls are covered by the moss *Drepanocladus* sp., the slopes have *Rubus chamaemorus*, *Sphagnum russovii*, and on the bottom one frequently encounters *Eriophorum scheuchzeri*, *E. russeolum*. The fissures reach a depth of 1.0 - 1.2 m and the average depth is 60 - 70 cm. The deepest fissures have a continuous growth of *Nardosmia frigida*. At times the depressions are occupied by a shrub-sedge-moss bog where there are many *Salix myrtilloides*, *Chamaedaphne calyculata*, *Andromeda polifolia*, *Betula exilis*, *Carex aquatilis*, *C. rotundata*, *C. limosa*. Depressions of this type are encountered on the lower lying moist terraces.

A specimen of the phytomass was taken from a peat mound (Table II). The root mass in this case was not determined because of the difficulty in washing the peat from the roots.

The composition of the living aboveground mass was as follows: shrubs - *Betula exilis*, *Ledum decumbens*, *Vaccinium uliginosum*, *Andromeda polifolia*; lichens - *Cladonia rangiferina*, *C. silvatica*, *C. alpestris*, *C. coccifera*, *C. gracilis*, *Cetraria cucullata*, *C. islandica*, *C. nigricans*; mosses - *Dicranum angustum*, *Aulacomnium palustre*; forbs - *Pedicularis sudetica*.

2. The spotty shrub-sedge-moss tundra occurs extensively on terraces and interfluvies. The spots occupy 10 - 20% of the surface; most of them are wrinkled, invaded by vegetation, and have clay loam soil. The interstitial areas are occupied by stands of shrubs and grasses; the moss cover is thick and at times holds some lichens. Five to ten percent of the surface of the spots is covered by *Vaccinium vitis-idaea*, *Juncus castaneus*, *Nardosmia gmelinii*, *Tofieldia nutans*, *Carex capillaris*, *Equisetum arvense*.

The composition of the living aboveground mass is as follows: shrubs - *Betula exilis*, *Salix lanata*, *S. glauca*, *S. pulchra*, *Vaccinium uliginosum*, *Ledum decumbens*, *Dryas punctata*; grasses and sedges - *Arctagrostis latifolia*, *Deschampsia brevifolia*, *Carex hyperborea*, *C. capillaris*; forbs - *Pirola grandiflora*, *Equisetum arvense*, *Nardosmia gmelinii*; lichens - *Cetraria cucullata*, *Cladonia silvatica*; mosses - *Hylocomium splendens*, *Ptilium crista-castrensis*, *Tomenthypnum nitens*, *Aulacomnium turgidum*, *Rhytidium rugosum*.

3. Alder stands are common on slopes and hilltops and form an almost continuous cover on terraces. About 5% of the area is covered by spots. The *Betula exilis* story is very well developed, reaching a height of 1 m. Lichens dominate in the soil cover and the moss *Ptilidium ciliare* is present. Occasional spots are covered by *Dryas punctata*, *Vaccinium vitis-idaea*, *Festuca brevifolia*.

The composition of the living aboveground mass is as follows: bush - *Alnus fruticosa*; shrubs - *Betula exilis*, *Ledum decumbens*, *Salix lanata*, *S. pulchra*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Dryas punctata*; grasses and sedges - *Carex hyperborea*, *Festuca brevifolia*; lichens - *Cetraria cucullata*, *C. islandica*, *Cladonia amaurocraea*, *C. gracilis*, *C. rangiferina*, *C. coccifera*, *C. alpestris*, *C. deformis*; mosses - *Ptilium crista-castrensis*, *Polytrichum piliferum*, *Ptilidium ciliare*, *Dicranum angustum*, *Aulacomnium turgidum*, *Hylocomium splendens*.

Table II. Vegetal mass of some types of plants in the northern treed tundra subzone.

Organic matter	Peat bog; shrub lichen community		Tundra on interfluvial			
			Spotty shrub- sedge-moss		Shrub-moss alder stands	
	Centners/ha	%	Centners/ha	%	Centners/ha	%
Total	not determined		1161.66	100	1073.06	100
Underground mass	not determined		983.35	80.4	652.62	60.8
Aboveground mass	368.09	100	228.31	19.6	420.44	39.2
Dead above- ground remains	199.75	57.4	136.29	11.7	105.32	9.7
Live aboveground mass						
Total	168.34	42.05	92.02	7.96	315.12	29.5
Alder brush					146.8	13.6
Shrubs	45.28	13.1	35.75	3.07	86.57	8.06
Sedges and grasses	traces		7.96	0.69	2.8	0.26
Forbs	1.41	0.4	0.9	0.08	traces	
Mosses	19.45	5.6	40.18	3.5	56.2	5.37
Lichens	102.2	28.2	7.23	0.62	23.75	2.21

Thus in the shrub and cottongrass-tussock tundra subzone the vegetation mass varies within the range of 500 - 1330 centners per hectare. The difference is due basically to the amount of root mass (Aleksandrova, 1958; Vikhireva-Vasil'kova *et al.*, 1964). The quantity of living aboveground mass is more constant (40-50 centners per hectare). Exceptions are meadows and shrub communities of sandy portions of floodplains adjacent to river channels and on terraces where there is no moss cover.

The largest quantity of organic matter is found in the moss tundra of the central floodplain and the interfluvial spotty and tussocky tundras. The greater part of it consists of roots and dead aboveground mass (Table I).

On the three plots investigated in the northern treed tundra subzone we found 1100-1200 centners per hectare of organic matter. The underground part and the dead aboveground mass are less than in the tundra region, whereas the live aboveground mass is considerably greater, 100 - 300 centners per hectare (Table II).

The basic part of the live aboveground mass in both regions consists of moss and shrubs. The contribution of grass components in the plant community is very small.

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